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MEANS OF PLANT DISPERSION.

BY E. J. HILL.

(Continued from August number.)

III. A third agency in the distribution of plants is that of animals. The adaptations of fruits and seeds for this purpose commonly assume the form of hooks and spines, attached in various ways so as to secure their adhesion to animals. The attachment may be straight, but is more often curved, or if straight, provided with barbs. It may be only a slight hook, as in the curved beak of the fruit of *Ranunculus sceleratus*, or strongly hooked and barbed, as in the cockle-bur (*Xanthium strumarium*). Several of these contrivances deserve special notice.

In the order Leguminosæ, we find the pods of *Desmodium canescens*, and some others of the genus, covered with hairs having incurved tips, and easily adhering to the coat of any passing animal. In the order Rosaceæ some forms of Geum, notably *G. rivale*, have a persistent style, which, being bent or jointed and becoming hard when ripe, serves the same purpose. In Agrimonia the top-shaped persistent calyx is covered near the upper margin with hooked bristles which harden at the time of fruiting, and aid in attaching it. Among the Onagraceæ, the bur-like fruit of *Circæa*, or enchanter's nightshade, is covered with the same kind of curved hairs. In the Umbelliferæ, our two species of sanicle, *Sanicula marylandica* and *S. canadensis*, have the fruit thickly coated with hooked prickles. In Osmorhiza, or sweet cicely, the ribs of the fruit are barbed and cling to an object with considerable force. In the madder family several species of *Galium* have fruit in the form of a bur, furnished with hooked bristles.

But some of the best examples of this mode of attachment are in the Compositæ, in which exist so many cases of wind dispersion. The cockle-bur has already been mentioned. The involucre of the fruit is closed over the bony nut and clothed with hooked and roughened prickles, whose power of adhesion is too well known to need description. In the burdock (*Lappa*) each scale of the involucre ends in an awl-shaped, hooked appendage to scatter the heads of fruit, to the great annoyance of flocks and herds. In *Coreopsis*, or tick-seed, the modified pappus secures this result. The flat achenium is tipped with two straight awns, sharp and stiff, which act as spears to be thrust into the hairy or

wooly coats of animals. In the allied *Bidens*, or bur-marigold, the awns are downwardly barbed for more efficient action, and act on the principle of the fishhook. Let one but walk among these weeds in autumn, when the fruit is ripe and ready to be dispersed, and the utility of the apparatus at once becomes apparent.

Another family well represented by burs is the *Borraginacææ*. In *Echinosperrum*, or stick-seed, the margin of the nutlet is armed with one to three rows of prickles curved at the apex. In *Cynoglossum*, or tory-bur, three species of which are found in our Northern flora, the nutlets are covered with these barbed and incurved prickles. In regions where sheep are kept, the troublesomeness of the tory-bur and beggar's lice (*C. morisoni*) are only too well known.

One of the grasses is furnished with efficient means of dissemination by animals, *i. e.*, *Cenchrus tribuloides*, the sand-bur, growing abundantly in waste places and roadsides, in dry, sandy ground. The persistent involucre, enveloping the fruit, becomes dry and hard, and is covered with hooked spines, very adhesive to any soft object that comes in contact with them. Even some of the bearded grasses, like *Elymus*, with their rough awns, have some power of sticking to the coats of animals.

The agency of animals in diffusing the spores of cryptogamous plants must not be omitted. Insects, crawling over these when in fruit, must get their bodies well dusted with the microscopic spores, and carry them away, as in the analogous case of the pollen of flowers for cross-fertilization. The spores are sometimes roughened by minute projections, appearing granulated or even spinescent, like the pollen grains of *Malvaceæ* and many *Compositæ*, more adequately preparing them to cling to the bodies of insects and other animals. Several mosses have these roughened spores, as *Aphanorhegma*, *Pylaisæa velutina*, *Physcomitrium pyriforme*, *Trichostomum pallidum* and others that might be mentioned. That Bacteria and Micrococci are thus carried by animals is proved by recent research. When they are found in such vast numbers in the air, they must of necessity lodge on the bodies of animals and on plants that are in process of movement, and be dispersed in this manner. J. B. Schnetzler states "that the dejections of earthworms always contain numerous living Bacteria and their germs."¹

¹ Journal of Royal Mic. Soc., Oct. 1882, p. 658.

The agency of animals in carrying fruits for food is an important factor in plant dispersion. They are often taken from the place of growth to be consumed in some other locality, or stored for future use. But all are not eaten. They may be dropped or abandoned. Accident or fright may lead the animal to relax its hold, and the fruit falls to the ground. The habit some animals have of burying fruit contributes still more effectually to this end, since some will escape consumption and be securely planted for growth. Busy rodents, apparently living for their own enjoyment, are contributing to the dissemination of their own food-plants. Darwin¹ states that earthworms are in the habit of lining their burrows, using seeds among other things, and that these sometimes sprout and grow. In this way these humble animals aid in spreading plants.

This is doubtless one of the ways in which acorns are scattered in regions of pine, which, cleared by the axe of the lumberman or destructive fire, soon yield a growth of oak, appearing almost spontaneously. The oaks found here and there in pine forests furnish the seeds; it only needs some mode of dissemination to plant them, like the agency of animals, wind and water. In passing through some of the burnt districts of Michigan, I have noticed that oaks sometimes escaped destruction by withstanding a fire that had killed nearly every pine, whose resinous bark invites death by fire. The scattered oaks stood ready to furnish the soil with another covering of trees, even if the ground were not already stocked with their germs.

In a similar way the habits of birds are available in the distribution of plants. Those yielding the softer fruits are largely dependent on them for dispersion. In the case of stone-fruits like plums and cherries, they eat the softer parts, the seed is generally untouched. And birds are wont to carry the fruit away from the tree that bears it, to be eaten elsewhere. The robin, woodpecker and other frugivorous birds, after plucking the dainty fruit are often seen to fly off with loaded beak. They may be carrying food to their young, but they are quite as apt to be seeking some better spot for the enjoyment of their meal. In either case the seed is scattered. And the seeds of many berries, hard achenia or minute stones or nuts, pass through the alimentary canal of birds and other animals undigested, and germinate from their

¹ Vegetable Mold and Earthworms, p. 113.

droppings. In this manner raspberries, blackberries, strawberries, the elder (*Sambucus*), poke (*Phytolacca*) and many others, which furnish food to birds, are multiplied.

It is therefore evident that the larger edible fruits, with their rich pulpy sarcocarp and much smaller volume of seed, do not exist alone for the animals that feed on them, but have another end to serve, the preservation of their kind. The more attractive the more likely to gain in the struggle for existence. If the color, form, odor, or any other peculiarity of a flower be explained on the principle that its end is the advantage of the plant bearing it, so we are to consider our various fruits as largely subject to the same law. There is mutual adaptation in the two kingdoms of nature, proceeding from its wise Author, but so far as the plant and animal are concerned, they are governed by a selfish principle, the law of self-preservation. The beauty we admire in the scarlet aril enclosing the seeds of the wax-work (*Celastrus*) and waahoo (*Euonymus*) when the pod opens to display them in the fall; the redness of the berries of the elder (*Sambucus pubens*), and of the mountain ash (*Pyrus americana*), are so many signals held out to attract the eye of the passing bird, inviting it to come and eat, however much they may contribute to the enjoyment of the eye that dwells upon their color.

IV. Another contrivance for spreading seed is the elastic movement of the coats of the seed-vessel at the time of maturity. Some of the best and most familiar examples are in the geranium family. The two wild species of *Impatiens* (*I. fulva* and *I. pallida*) are excellent cases of this kind. The walls of the ripened pods, still considerably succulent, suddenly contract and roll together, especially if some external stimulus be applied, as a touch or the action of the wind, and throw the seed outward to some distance from the plant. The wild species are exceedingly sensitive, opening so suddenly and at so slight a touch as to be almost startling in its unexpectedness, and hence have acquired their common name, touch-me-not. The wild geraniums possess this property, but to a less marked degree. The receptacle of the flower is prolonged into a slender beak, around which, at the base, the five cells of the capsule are arranged. Each cell tapers upward into a slender prolongation formed by the hardened style, and adheres to the beak at the top. When ripe they break away from the base, curl upward so as to bring the inside of the cell outward,

and in the elastic movement project the seed with force. The valves of the pods of violets also fold together when ripe, and throw out the seeds attached to the middle part of them. Hamamelis, or witch-hazel, is even more remarkable; the fruit is a two-celled, woody pod, opening at the top. Each cell usually contains but a single bony seed. When mature the outer coat of the cell separates from the inner, which encloses the seed. This, pressing the seed as it bursts elastically from the top, often throws it several feet as it escapes from the pressure, like a boy shooting a pea or bean by pressing it between the two parts of a split stick. These movements are generally due to the unequal tension of cells on the outer and inner sides of the walls, causing a rapid warping together in the direction of the greatest strain, and are similar to many other plant movements, like the bursting of the anthers in the barberry.¹

It will be seen from what has been brought to notice that a great many kinds of plants are provided with means of dispersion, and that we can find genera and species in a large number of families that furnish examples of special contrivances. No effort has been made to be exhaustive in the treatment of the subject, even for our own flora, as it has not received sufficient attention to admit of this. But that the greater part of plants can avail themselves of some agency, either in themselves or their surroundings, or both, seems very evident; it may be said, scarcely admits of doubt. It is in accordance with the great plan of nature that all shall be cared for.

Nothing has been said about the indirect aid furnished by man any further than that of any animal. I have frequently been entertained, even if annoyed, while collecting plants, by an involuntary contribution to this work. With clothes well covered with burs and other adhesive fruits, the lesson has been learned to generally let them alone, not picking them off one by one, but leaving them to be brushed off in neighboring clumps of bushes or patches of grass that may soon be the place of search, where most will disappear and be left to propagate their kind. At some times of the year a day's work in gathering is also a day's work in dispersing. The indirect scattering of seeds by railroads, as

¹ Mr. J. C. Arthur, of Charles City, Iowa, being present at the reading of this paper, and engaging in the discussion that followed, stated that he had observed species of *Euphorbia* projecting their seeds with force from their pods.

the chief carriers of produce, with which seeds are more or less mixed, may also be noticed. That plants migrate along their road-beds, where they find a natural highway, is evident from the manner in which the plants of different regions are found to be mingled, when capable of this migration, going along step by step. But they too travel by rail, like members of the other kingdom of nature, and the diligent collector will from time to time be rewarded with a species new to his locality, which by its sudden appearance and isolation will not easily be accounted for in any other way.

In relation to what has been said, it is a matter of interest to compare plants and animals with reference to their distribution, and see which has the advantage in the struggle for existence. It may be thought that the free-moving animal excels the fixed plant in this respect. But a study of the whole life of each shows that many species of plants have the advantage over animals. If we compare the faunas and floras of the different continents, or of wide regions of the same continent, the number of plants of wide distribution much exceeds the number of animals. It is especially true of cryptogamous plants, and in the northern parts of the northern continents. Of the 2928 species of plants given in Gray's *Manual of Botany*, 2668 are indigenous, and 676 indigenous species are common to Europe, or twenty-five per cent. Of the mosses, including Hepaticæ, 502 are enumerated, 320 of which are found in Europe, or sixty-three per cent. Of the vascular Cryptogams, thirty-five of the seventy-five are common to the two continents, or about fifty per cent.¹ Some changes would have to be made in these figures if a comparison based on later discoveries were instituted, but not materially affecting the principle of distribution involved. This comparison is made between land and fresh-water plants and animals dwelling under the same conditions. It may be different with marine plants and animals. This advantage of the plant is doubtless in a great part attributable to its greater capability of enduring changes while in the act of migration. It is of a lower order of life, and less sensitive to change in some stages of its existence. Mountains, often of no great height, seas, often of no great width, are insuperable barriers to the migration of animals; they perish by cold, or hunger, or drowning, in their attempts to cross them.

¹ Gray's *Manual of Botany with Mosses*, 1856. Introduction.

But the embryo plant, wrapped in its seed or spore, more easily overcomes these obstacles. Before it becomes a rooted organism it has a greater freedom.

This idea may be enforced by quoting a few sentences from a work already referred to, that of Hildebrand: "It might seem that animals, in their ability to move freely over the surface of the earth, had a great advantage over plants in their dissemination. But plants find a compensation that more than offsets their lack of free movement. It consists in the fact that their descendants, before striking root in the ground, can, by means of various contrivances, be spread around the parent plant in a wide circle, and reach a place to which an animal can scarcely attain, notwithstanding its ability to move freely. There are a great many obstacles which cannot be overcome by an animal that walks or flies. It is not able to pass over a chain of mountains of a certain height, or cross a broad expanse of water by swimming or flying. If permitted by its organization to live only in a marsh, it cannot wander from one marsh to another, or far away from the marsh in which it lives. * No more can an animal, whose home is in the forest, master the difficulties of broad, treeless plains. But all these hindrances are more or less easily overcome by the seeds of plants. Being provided in themselves or their surroundings with the most varied equipments, they are borne far away by wind and water; and even in spreading obtain aid from the freedom of movement of animals, by whom they may be carried to distant places."¹

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IS THE GROUP ARTHROPODA A VALID ONE?

BY J. S. KINGSLEY.

SEVERAL years have passed since the four sub-kingdoms of Cuvier—radiates, mollusks, articulates and vertebrates—fell, more or less, into disuse, and now in their places we find a number of groups, varying according to the author followed. But by all the group Arthropoda is accepted, only a very few, in print, expressing any doubts as to its validity. The question of its naturalness we here propose to discuss in a very brief manner.

According to the old canons of classification, comparative anatomy was made the basis of systematic arrangement, and

¹ Die Verbreitungsmittel der Pflanzen, pp. 1, 2.